Nickel metal hydride battery

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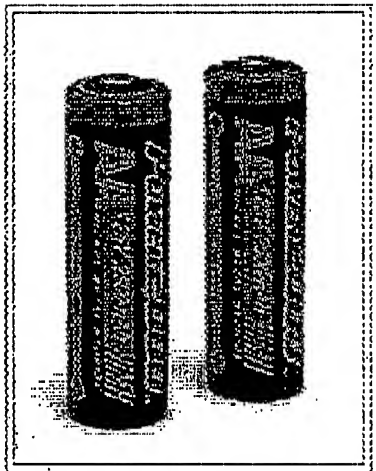

Modern, high capacity NiMH rechargeable batteries

A nickel metal hydride (or **NiMH**) battery is a type of rechargeable battery similar to a nickel-cadmium (NiCd) battery but has a hydrogen absorbing alloy for anode instead of cadmium (which is an environmental hazard); therefore, it is less detrimental to the environment. A NiMH battery can have 2 to 3 times the capacity of an equivalent size NiCd and the memory effect is not as significant. However, compared to the lithium ion chemistry, the volumetric energy density is lower and self-discharge is higher. Applications of NiMH type batteries includes hybrid vehicles such as the Toyota Prius and consumer electronics. The NiMH technology will also be used on the Alstom Citadis low floor tram ordered for Nice, France. Standard NiMH batteries perform better with moderate drain devices such as digital cameras, flashlights, and other consumer electronics, but, because NiCd batteries have lower internal resistance, they still have the edge in very high current drain applications such as cordless power tools and RC cars.

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Charging

When fast-charging, it is advisable to charge the NiMH batteries with a smart charger to avoid overcharging, which can damage batteries and cause dangerous conditions. Modern NiMH batteries contain catalysts to immediately deal with gases developed as a result of over-charging without being harmed ($2\ H_2 + O_2$ ---catalyst--> $2\ H_2O$). However, this only works with over-charging currents of up to *C*/10 h (nominal capacity divided by 10 hours). As a result of this reaction, the batteries will heat up considerably, marking the end of the charging process. Some quick chargers have a fan to keep the batteries cool.

Some equipment manufacturers consider that NiMH can be safely charged in simple fixed (low) current chargers with or without timers, and that permanent over-charging is permissible with currents up to *C*/10 h. In fact, this is what happens in cheap cordless phone base stations and the cheapest battery chargers. Although this may be safe, it may not be good for the health of the battery. According to the Panasonic NiMH charging Manual (link below), permanent trickle charging (small current overcharging) can cause battery deterioration and the trickle charge rate should be limited to between $0.033 \times C$ per hour and $0.05 \times C$ per hour for a maximum of 20 hours to avoid damaging the batteries.

Long term maintenance charge of NiMH batteries needs to be by low duty cycle pulses of high current rather than continuous low current in order to preserve battery health.

Brand new batteries, or batteries which have been unused for some time, need "reforming" to reach their full

capacity. For this reason new batteries may need several charge/discharge cycles before they operate to their advertised capacity.

Discharging

Care must also be taken during discharge to ensure that one or more cells in a series connected cells (for example the common arrangement of four AA cells in series in a digital camera) do not become completely discharged and go into polarity reversal. Polarity reversal can cause permanent damage to cells. Some devices (cameras, GPS, PDA and etc) detect the safe end of discharge voltage of the series cells and shut themselves down, but devices like flashlights and some toys do not. Once noticeable dimming or slowing of the device is noticed, it should be turned off immediately to avoid polarity reversal.

A single cell driving a load doesn't suffer from polarity reversal.

NiMH chemistry has a somewhat higher self-discharge than the NiCd chemistry. The self discharge is 5-10% on the first day, and stabilizes around 0.5-1% per day at room temprature. The rate is strongly affected by the temperature at which the batteries are stored.

Other information

Common penlight-size (AA) batteries have nominal capacities *C* ranging from 1100mAh to 2700mAh at 1.2v, usually rated at 0.2C rate. Useful discharge capacity is an inverse function of the discharge rate, but up to around 1C rate, there is no significant difference. NiMH batteries have an alkaline electrolyte, usually potassium hydroxide. The specific energy density for NiMH material is approximately 60 W·h/kg (220 kJ/kg), with a volumetric energy density of about 100 W h/L (360 MJ/m³).

NiMH battery technology was developed by Michigan-based Ovonic Battery, a division of ECD Ovonics (www.ovonic.com), the company founded in the 1950s by a physicist Stanley Ovshinsky. NiMH batteries were made available to the public in 1983.

Chemistry

The reaction occurring in a NiMH battery is as follows: $H2O + Mm + 2electrons <--> OH- + 0.5H2$ (stored as Mm-Hx) The battery is charged in the right direction of this equation and discharged in the left direction. Mm stands for Mischmetal. One should note that the hydrogen evolved during charging is stored as Mm-Hx, the metal hydride of the battery It is not evolved as a gas.

The "metal" in a NiMH battery is actually an intermetallic compound. Many different compounds have been developed for this application, but those in current use fall into two classes. The most common is AB_5, where A is a rare earth mixture and/or titanium and B is nickel, cobalt, manganese, and/or aluminum. Higher-capacity "multi-component" electrodes are based on AB_2 compounds, where A is titanium and/or vanadium and B is zirconium or nickel, modified with chromium, cobalt, iron, and/or manganese [1] (http://www.cobasys.com/pdf/tutorial/inside_nimh_battery_technology.pdf).

Any of these compounds serves the same role, reversibly forming a mixture of metal hydride compounds. When hydrogen ions are forced out of the potassium hydroxide electrolyte solution by the voltage applied during charging, this process prevents them from forming a gas, allowing a low pressure and volume to be maintained. As the battery is discharged, these same ions are released to participate in the reverse reaction.

See also

- Category:NiMH chargers
- Category:NiMH batteries

External links

- Panasonic NiMH charging manual (PDF) (http://www.panasonic.com/industrial/battery/oem/images/pdf/Panasonic_NiMH_ChargeMethods.pdf)
- "The Nickel-based Battery" at BatteryUniversity.com (http://www.batteryuniversity.com/partone-4.htm)
- Battery Care & Tips (http://wireless.berkeley.edu/services/battery.shtml)
- NiMH Battery Handbook (http://www.hardingenergy.com/pdfs/NiMH.pdf)
- Steve's Digicams - Rechargeable Battery Information (http://www.steves-digicams.com/nimh_batteries.html)
- NiMH Batteries and Chargers - Knowledge Base (http://www.nimhbattery.com/forum/1.html)
- R/C Battery Clinic (http://www.rcbatteryclinic.com/)
- Batteries in a Portable World (http://www.buchmann.ca/)
- Battery Chargers and Charging Methods (http://www.mpoweruk.com/chargers.htm)

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